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II. Scientific Report

In order to increase our understanding about the etiology and mechanism of space motion sickness, a strong demand existed to establish an appropriate animal model to gain much more insightful knowledge so that we will be able to offer a better control on this distress condition. Among various primate species the squirrel monkey was the prime choice based on many reasons including their handy compact body size etc. The following description summarizes some of the highlight information acquired during this grant period.

- (a) By using sinusoidal rotatory stimulus of both vestibular and optokinetic modality, we could produce sensory conflict sickness - emesis in this animal model. Considerable difference existed in individual susceptibility but we could find out appropriate number of animal subjects for further experimentation.
- (b) When the exactly identical vestibular - visual conflict was given to the subjects, severer and higher % of conflict sickness was found when the stimulus was given in pitch plane compared to those evoked in yaw plane. This result ; the stimulus given in pitch plane is more stimulatory, is somewhat parallel to the findings in space motion sickness and also in reverse-prism sickness.
- (c) Otolith end organs are prime gravitoceptors and when they input altered and somewhat never-experienced afferent signals, space motion sickness occurs. If there is no such irregular inputs, space sickness may not occur. In our primate model, when all otolith end organs were ablated, conflict sickness could not be evoked. Similarly another mode of stimulus ; up-and-down table rotation, also failed to provoke sickness after otolith organ ablation.
- (d) Conflict sickness susceptible animals showed more irregularities in their oculomotor functions than those in non-susceptibles. Thus, conflict sickness susceptibility and oculomotor modulation in response to conflict stimulus could be related each other via some higher central neural structures.
- (e) In conflict sickness susceptible animals, when repetitive conflicts were given in a variety of conflict modes, susceptibility declined temporarily. It is somewhat believed that the incidence of space motion sickness is slightly lower when the astronaut has an experience of space flight, even though it could be based on a long-term memory. Our experimental finding suggested the existence of short-term memory of sensory conflict and its effectiveness in controlling the evocation of conflict sickness.
- (f) Objective assessment of motion sickness symptomatology is not very easy in man and it is even more difficult in experimental animals. In order to analytically investigate autonomic nervous system function in experimentally evoked motion or conflict sickness in squirrel monkeys, first we established the method to study the coefficient of variance of R - R intervals with an aid of computer analysis. By doing this way we could see the parallel build-up of both conflict sickness and CV of RRI. We could recognize similar changes in man during the parabolic flight and also during the Colioli exposure (unpublished data). Thereafter, we also studied autonomic nervous system condition by analysing biochemical components of saliva during the conflict sickness in squirrel monkeys and during the Conflict sickness in man. Among many components, we found that sodium concentration and total protein concentration are the best parameters to represent the change in autonomic nervous system function.

Furthermore, non-stimulated baseline value of total protein may represent, at least in part, the individual's susceptibility to motion sickness.

(g) Asymmetric up/down gain of vertical optokinetic nystagmus has been known for some time both in man and monkeys. For the first three days in space, the directional dominance of this asymmetry reversed, indicating that the reduction of gravitoception produced this change. We hypothesized that this phenomenon is due to the reduction of saccular afferent input to group y which excites the so-called head and eye upward neurons, thus removing gravity cues from saccular macula will produce the increased gain toward the downward direction. When bilateral sacculotomy was placed in squirrel monkeys, their vertical optokinetic asymmetry showed a reversed trend. This sort of change may have some impact to produce spatial dysorientation in microgravity.

(h) We have been utilizing, for several years, immunohistochemical labeling method and biochemical analysis of neurochemicals by HPLC, to increase our understanding about vestibular compensation. Insofar as vestibular compensation can be considered as a working model, at least in part, of space adaptation, we can reasonably speculate the importance of certain neurotransmitters related to space adaptation.

(i) We have been working on otolith organ and otoconia morphogenesis in chick embryo model. Importance of calcium channel is clear and, in space, if there be a serious change, otoconia turn-over could have a problem. In case otoconia crystal is formed in a different way and form large giant otoconia like other organic or vapor crystal formation in space, then such an individual could have a serious trouble when he returns to earth 1G environment.

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